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SUPERFUND TREATABILITY CLEARINGHOUSE

Document Reference:

International Technology Corp., AFESC, EG&G Idaho, Inc. "Technology Demonstration of a Thermal Desorption/UV Photolysis Process for Decontaminating Soils Containing Herbicide Orange." Prepared for EG&G Idaho. 14 pp. Technical report.

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SUPERFUND TREATABILITY CLEARINGHOUSE ABSTRACT

Treatment Process:	Physical/Chemical - UV Photolysis
Media:	Soil/Generic
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Document Type:	Contractor/Vendor Treatability Study
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Site Name:	NCBC Gulfport, MS; Johnston Island; and Guam (Non-NPL)
Location of Test:	Gulfport, MS and Guam

BACKGROUND: This treatability study report presents the results of laboratory and field tests on the effectiveness of a new decontamination process for soils containing 2,4-D/2,4,5-T and traces of dioxin. The process employs three operations, thermal desorption, condensation and absorption of contaminants into a solvent and photo decomposition. Bench-scale tests were conducted to establish the relationships between time and temperature and treatment efficiency. A pilot-scale (100 lbs/hr) system evaluation was conducted at two sites to evaluate system performance and develop scale-up information.

OPERATIONAL INFORMATION: The intent of the laboratory and pilot-scale tests was to reduce the combined dibenzo dioxin and furan constituents, which originate from Herbicide Orange (HO), to less than 1 ng/g. This level represents the anticipated soil cleanup criteria. The soils used had similar concentrations of HO contaminants, but were different types of soil. In the laboratory the contaminated soil is passed through thermal desorber and the off gases from the soils, including the contaminants, are passed through a scrubber that uses a hydrocarbon solvent. Contaminants dissolve in the solvent and the solvents are passed through a flow reactor which subjects the contaminant to UV radiation to decompose the contaminant molecules. Testing was conducted on soil samples from three HO contaminated sites; Johnson Island, Eglin AFB and NCBC in Biloxi, MS. The soils tested had 2,3,7,8-TCDD concentrations greater than 100 ng/g of soil and 2,4,-D/2,4,5-T levels greater than 1000 ng/g soil. Tests were run at three different temperatures and two different power levels using high intensity UV quartz mercury vapor lamps.

Pilot tests were conducted at the NCBC site using a rotary indirect calciner as the desorber, an off gas transfer and scrubber system and a

photo chemical reactor to irradiate the contaminants contained in the scrubber solution. A 1200-watt high intensity mercury vapor lamp was used to irradiate the contaminated scrubber solution. No QA/QC plan was contained in the document. No discussion of analytical techniques utilized to detect HO and associated compounds is contained in the paper. A detailed list of soil properties (particle size distribution, surface area, organic matter, etc.) from the three different sites is contained in the document.

PERFORMANCE: Laboratory studies revealed that thermal desorption/UV photolysis destroyed all compounds to below their analytical detection limit (which was generally less than 0.1 ng/g). The concentration of 2,3,7,8-TCDD was reduced from 200 ng/g to less than 1 ng/g. Insoluble brown tars (presumably phenolic tars) were deposited on the surfaces of the reactor vessel and lamp well. Reaction kinetics quantum yields' and rate constants were determined. Pilot tests also produced soil containing less than 1 ng/g of 2,3,7,8-TCDD. Table 1 shows the results of the tests.

CONTAMINANTS:

Analytical data is provided in the treatability study report. The breakdown of the contaminants by treatability group is:

Treatability Group	CAS Number	Contaminants
W02-Dioxins/Furans/PCBs	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)

TABLE 1

EFFECT OF TREATMENT CONDITIONS ON RESIDUAL 2,3,7,8-TCDD DURING NCBC PILOT THERMAL DESORPTION TESTS

Test No.	Soil Feed Rate (kg/hr)	Residence Time[a] (min)	Soil Temperature (^{o}C)	2,3,7,8-TCDD[b] (ng/g) Initial	Residual
1	13.6	40	560	260	ND
2	13.6	40	560	272	ND
3	25	19	560	236	ND
4	44	10.5	560	266	ND
5	20	24	460	233	0.5

Notes: a) Soil residence time in heated zone.
b) Detection level for 2,3,7,8-TCDD was generally less than 0.1 ng/g with a range of 0.018 to 0.51 ng/g.
c) This is a partial listing of data. Refer to the document for more information.

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Technology Demonstration of a Thermal Desorption/UV Photolysis Process for Decontaminating Soils Containing Herbicide Orange

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Laboratory and field testing determined the effectiveness of a new decontamination process for soils containing 2,4-D/2,4,5-T and traces of dioxin. The process employs three primary operations - thermal desorption to volatilize the contaminants, condensation and absorption of the contaminants in a solvent, and photochemical decomposition of the contaminants. Bench-scale experiments established the relationship between desorption conditions (time and temperature) and treatment efficiency. Laboratory tests using a batch photochemical reactor defined the kinetics of 2,3,7,8-TCDD disappearance. A pilot-scale system was assembled to process up to 100 pounds per hour of soil. Tests were conducted at two sites to evaluate treatment performance and develop scale-up information. Soil was successfully decontaminated to less than 1 ng/g 2,3,7,8-TCDD at temperatures above 460°C.

As part of a major program being conducted by the U.S. Air Force to restore to normal use several Department of Defense sites where soils have been contaminated with low levels of Herbicide Orange (HO), International Technology Corporation (IT), under subcontract to EG&G Idaho, has been conducting a project involving laboratory bench-scale and field pilot-scale tests to demonstrate a new soil treatment process - thermal desorption/UV photolysis (TD/UV). The intent of the demonstration was to reduce the combined tetra-, penta-, and hexa-chlorinated dibenzodioxin (CDD) and furan (CDF) congeners, which originated from the HO, to less than 1 ng/g, which represented the anticipated soil clean-up criteria. Treatment should also effectively remove the primary HO constituents, 2,4-D

and 2,4,5-T. Two sites were included in the field demonstration project for the TD/UV process, each having substantially different types of soil but reasonably similar concentrations of the HO constituents. Testing at the Naval Construction Battallion Center (NCBC) at Gulfport, Mississippi was conducted by IT during May 1985; testing at Johnston Island (JI) in the Pacific Ocean occurred in July 1986. Based on the results of these field pilot demonstrations, an engineering and cost evaluation is being performed for applying TD/UV technology using large, mobile systems for these two sites or other sites having similar contaminated soil problems. This paper describes the technology, highlights the results of the initial laboratory test phase, and summarizes the field demonstration results.

Process Description

The thermal desorption/UV photolysis process developed by IT accomplishes substantial volume reduction and toxicity reduction by concentrating the hazardous constituents contained in the soil into a small volume which is easier to treat than large quantities of soil. The process incorporates three steps:

Desorption - heating the soil to volatilize the organic contaminants
Scrubbing - collecting the volatilized organics in a suitable solvent
Photolysis - converting the contaminants to relatively non-hazardous residues through photochemical reactions.

A schematic block-flow diagram is presented as Figure 1. Contaminated soil is passed continuously through an indirectly heated desorber which can be one of many types of conventional equipment applicable for thermal processing of solids. The treatment performance of the desorber is controlled by the residence time and temperature of the soil. Treatment requirements (i.e., operating conditions) are determined by the volatility of the soil contaminants and the required contaminant removal efficiency (final versus initial concentration).

The off-gas leaving the desorber contains organic vapors, water vapor originating as initial soil moisture, and small quantities of air which enter with the soil. Scrubbing using a high boiling hydrocarbon solvent is used to treat the off-gas to remove the organic contaminants and water vapor by cooling, condensation, and absorption. Particulates (e.g., fine soil) which may be entrained by the off-gas are also collected by the scrubbing solvent. Scrubbed off-gas is passed through a conventional emission control system, such as carbon adsorption, to ensure that no organic contaminants or solvent vapors are released. Scrubber solvent is recirculated to the scrubber after being processed through a system of phase separation, filtration, and cooling. Condensed water, which is immiscible with the solvent, is separated and either directly treated using conventional techniques, such as filtration and carbon adsorption, or discharged to an existing